MAJOR ARTICLE

Reduction of Urinary Tract Infection and Antibiotic Use after Surgery: A Controlled, Prospective, Before-After Intervention Study

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Background. Urinary tract infection is the most frequent health care–associated complication. We hypothesized that the implementation of a multifaceted prevention strategy could decrease its incidence after surgery.

Methods. In a controlled, prospective, before-after intervention trial with 1328 adult patients scheduled for orthopedic or abdominal surgery, nosocomial infection surveillance was conducted until hospital discharge. A multifaceted intervention including specifically tailored, locally developed guidelines for the prevention of urinary tract infection was implemented for orthopedic surgery patients, and abdominal surgery patients served as control subjects. Infectious and noninfectious complications, adherence to guidelines, and antibiotic use were monitored before and after the intervention and again 2 years later.

Results. The incidence of urinary tract infection decreased from 10.4 to 3.9 episodes per 100 patients in the intervention group (incidence-density ratio, 0.41; 95% CI, 0.20–0.79; $P = .004$). Adherence to guidelines was 82.2%. Both the frequency and the duration of urinary catheterization decreased following the intervention. Recourse to antibiotic therapy after surgery dropped in the intervention group from 17.9 to 15.6 defined daily doses per 100 patient-days ($P < .005$) because of a reduced need for the treatment of urinary tract infection ($P < .001$). Follow-up after 2 years revealed a sustained impact of the strategy and a subsequent low use of antibiotics, consistent with stable adherence to guidelines (80.8%).

Conclusions. A multifaceted prevention strategy can dramatically decrease postoperative urinary tract infection and contribute to the reduction of the overall use of antibiotics after surgery.

Urinary tract infection (UTI) is the most common health care–associated adverse event and the leading nosocomial complication following joint prosthesis surgery [1, 2]. Presence of an indwelling urinary catheter is the main risk factor for infection [1, 3, 4]. In addition to the associated economic burden and patient morbidity [1, 2, 5, 6], UTIs contribute to the inappropriate and excessive use of antimicrobial agents and lead to the selection of antibiotic-resistant organisms, thereby creating a potential reservoir of resistant pathogens [1, 3, 7].

In most hospitals, urinary catheters are placed by anesthesiologists in the operating room and the postanesthesia care unit, and surgeons and nurses handle the placement of indwelling devices for patients in the surgical ward. Management of urinary problems relies more on the physician's experience and the surgery department's practice patterns than on evidence-based data. Specific recommendations related to urinary catheter placement during surgical procedures are lacking not only in anesthesiology and surgery textbooks, but also in published guidelines issued by local and national authorities [8–10]. We performed a multifaceted, multidisciplinary intervention study to decrease the incidence of nosocomial UTI in surgical patients and thereby improve quality of care and patient safety.

METHODS

Study design. We conducted a 3-phase, controlled, prospective, before-after intervention trial (quasi-ex-

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perimental study) with patients scheduled to undergo surgery in the orthopedic and abdominal surgery departments who were, therefore, likely to be exposed to urinary catheterization. The study was classified as B1 in the hierarchy of quasi-experimental study designs proposed by Harris and colleagues [11]. The study was approved by the institutional review board of the University of Geneva Hospitals, Geneva, Switzerland; no informed consent was requested.

Orthopedic surgery patients were assigned to the intervention group; abdominal surgery patients served as control subjects (figure 1). Baseline surveillance was conducted from November 2001 to January 2002 in both groups (phase I). Guidelines for perioperative urinary catheter insertion and management in orthopedic surgery patients were implemented in February 2002. Surveillance after the intervention continued in both groups from March to June 2002 (phase II). Follow-up surveillance (phase III) was conducted 2 years later, from April to June 2004, and included only orthopedic surgery patients.

Data collection. Variables included age, weight, height, body mass index, sex, comorbidities, immunosuppressive therapy, dates of admission and discharge from the hospital, date and type of surgery, American Society of Anesthesiologists (ASA) class [12], anesthetic technique, duration of anesthesia and surgical procedure, the need for transfusion of blood products, and total volume of intravascular infusion. In the postanesthesia care unit, the total dose of morphine, frequency of bladder volume determination, and the need for urinary catheterization were also recorded.

Surveillance. Surveillance of nosocomial infections was performed by a single infection-control physician who visited the postanesthesia and surgical wards daily (6 days per week) and completed a dedicated surveillance chart for each patient until hospital discharge. Infections were prospectively identified according to standard definitions [13,14]. In the surgical ward, the need for urinary catheterization and the duration of catheterization were noted. All surveillance records were reviewed and validated by a senior hospital epidemiologist.

Patients were questioned daily by the infection control physician regarding any discomfort or other symptoms potentially associated with the catheter, such as urethral or pelvic pain and a sense of urgency or dysuria, and records were reviewed for fever, antibiotic use, and clinical and laboratory data suggesting infection. Urine analysis was performed systematically after catheter removal or at the attending physician's discretion. A quantitative urine culture was performed if laboratory analysis suggested infection (e.g., suggested the presence of bacteriuria, pyuria, leukocyturia, or significant hematuria or positive test results for nitrite), or if the patient had symptoms of UTI or a fever of unknown origin.

Noninfectious complications were prospectively recorded using a complete patient chart review and an interview with the attending physician or nurse. These complications included cardiovascular events, such as pulmonary embolism, stroke, acute pulmonary edema, and myocardial infarction; need for reoperation; need for transfusion of RBCs; and occurrence of bed sores.

Surveillance protocols were unchanged during the 3 phases.

Patient care protocols and intervention. Indwelling urinary tract catheters (Silkotalex Rusch Gold; Rüsch GmbH) were inserted using the aseptic technique and sterile equipment [10] and were connected to a closed drainage system [15]. The intervention focused on perioperative urinary catheter management for orthopedic surgery patients. We designed a mul-

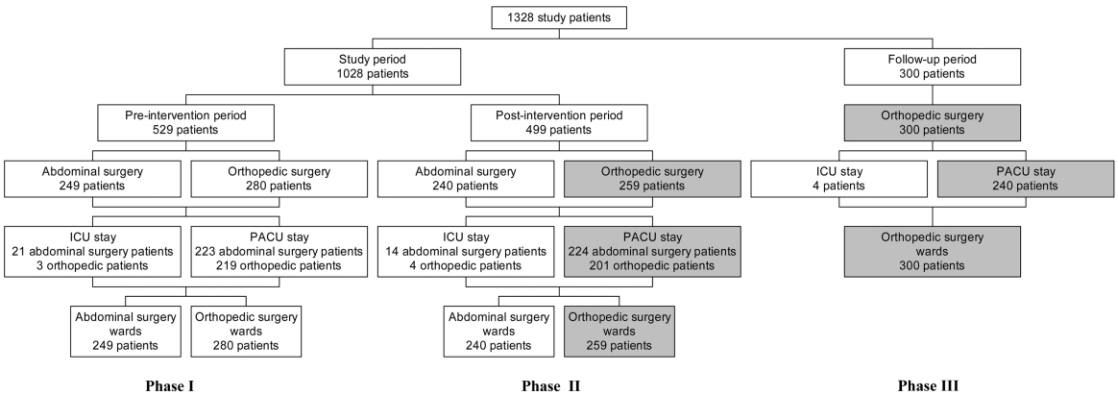

Figure 1. Study design and patient flow diagram. During phase I, 5 abdominal surgery patients and 58 orthopedic surgery patients were transferred directly from the operating room to the surgical wards. During phase II, 2 abdominal surgery patients and 54 orthopedic surgery patients were transferred directly from the operating room to the surgical wards. During phase III, 56 orthopedic surgery patients were transferred directly from the operating room to the surgical ward. Grey shading indicates the locations where the intervention was conducted. ICU, intensive care unit; PACU, postanesthesia care unit.

tifaceted intervention that combined specifically tailored, locally developed guidelines, educational sessions, and posters with a visual display of the guidelines. Guidelines were applied in the operating room, postanesthesia care unit, and surgical ward (figure 1). Criteria for the placement and management of urinary catheters in the operating room, postanesthesia care unit, and surgical ward follow.

In the operating room, urinary catheterization was restricted to patients with (1) interventions with a foreseen duration of surgery >5 hours; (2) total hip replacement or related surgery, if the patient met 1 of the following conditions: age >75 years, an ASA class ⩾3, obesity, or urinary incontinence; and (3) total knee replacement, if the patient met 1 of the following conditions: age >80 years, obesity, or urinary incontinence.

In the postanesthesia care unit, the decision to insert a urinary catheter followed these criteria: (1) the decision required the clinical judgment of a physician; (2) there was no routine requirement for urination before discharge [16]; (3) there was no routine determination of bladder volume by ultrasound and no decision for catheterization based on bladder volume measurement; and (4) a urinary catheter inserted because of long-duration surgery must be removed before discharge from the unit.

In the surgical wards, the urinary catheter was removed (1) on postoperative day 2 (i.e., the third day of catheterization) after total hip replacement or related surgery or (2) on postoperative day 1 after total knee replacement.

These guidelines were approved by the orthopedic department chair, senior nurses, and senior anesthetists of our institution. Rotating resident anesthetists were individually instructed. After an educational presentation on the epidemiology and prevention of UTI, guidelines were endorsed by nursing staff. Additional information was also given individually to nurses and physicians upon request. A4-format posters illustrating the guidelines and endorsed by the orthopedic department senior staff (department chair, senior nurse, and chief anesthetist) and the hospital infection control program director were displayed in all operating rooms dedicated to orthopedic

Table 1. Characteristics of orthopedic surgery patients during each study phase.

Variable	Preintervention (n = 280)	Postintervention (n = 259)	2-year follow-up (n = 300)	P
Age in years (range)	60.2 (16–97)	59.8 (17–93)	58.7 (16–98)	.62
Sex				.36
Male	132 (47)	113 (44)	149 (50)	
Female	148 (53)	146 (56)	151 (50)	
Body mass index (range)	25.7 (13.1–50.7)	25.8 (11.4–41.4)	26.3 (12.7–57.2)	.38
ASA class >2	76 (27.0)	56 (22.0)	61 (20.3)	.12
Diabetes mellitus	29 (10.3)	26 (10.0)	32 (10.7)	.97
Immunodepression	7 (2.5)	5 (2.0)	12 (4.0)	.31
Malnutrition	2 (0.7)	5 (1.9)	8 (2.7)	.20
Obesity	64 (22.8)	53 (20.5)	69 (23)	.72
Procedures				.24
Total hip replacement	72 (26.0)	68 (26.2)	80 (26.7)	
Total knee replacement	42 (15.0)	29 (11.2)	46 (15.3)	
Lower limb surgery	42 (15.0)	32 (12.4)	46 (15.3)	
Foot surgery	45 (16.0)	52 (20.0)	37 (12.3)	
Upper limb surgery	33 (11.8)	37 (14.3)	39 (13.0)	
Removal of orthopedic material	23 (8.2)	29 (11.2)	37 (12.3)	
Miscellaneous	23 (8.2)	12 (4.6)	15 (5.0)	
Anesthetic techniques				.52
General anesthesia with and without peripheral nerve blocks	163 (58.2)	157 (60.6)	188 (62.7)	
Spinal or epidural anesthesia with and without peripheral nerve blocks	57 (20.3)	38 (14.7)	44 (14.7)	
General plus spinal or epidural anesthesia	4 (1.4)	4 (1.5)	6 (2.0)	
Peripheral nerve blocks	56 (20.0)	60 (23.2)	62 (20.7)	
Volume infusion during procedure, mL (range)	1406 (100–5250)	1543 (220–8500)	1404 (100–8000)	.12
Dose of morphine administered in PACU, mg (range)	11.5 (1–60)	10.5 (1–60)	12.0 (2–189)	.70
Duration of hospitalization, mean days (range)	15.9 (1–167)	14.1 (1–107)	14.2 (1–161)	.27
Patient-days of follow-up	4462	3648	4261	

NOTE. Data are no. (%) of patients, unless otherwise indicated. ASA, American Society of Anesthesiologists; PACU, postanesthesia care unit.

Table 2. Urinary tract infection during preintervention and postintervention phases.

Patients with urinary tract infection	Preintervention phase (n = 529)		Postintervention phase (n = 499)		Incidence density ratio (95% CI)
	No. of episodes (per 100 patients)	Incidence density[a]	No. of episodes (per 100 patients)	Incidence density[a]	
Overall	35 (6.6)	27.0	13 (2.6)	12.0	0.44 (0.24–0.81)
Orthopedic surgery	29 (10.4)	45.8	10 (3.9)	18.6	0.41 (0.20–0.79)
Abdominal surgery	6 (2.4)	9.0	3 (1.25)	5.6	0.62 (0.14–2.50)

[a] Defined as the no. of episodes per 1000 catheter-days.

procedures, the postanesthesia care unit, and orthopedic nursing staff offices. Feedback on practice and results was provided 6 months after the completion of phase II.

Outcome measures. UTI was the primary outcome measure. The incidence rate refers to the number of new cases of infection per 100 patients. The device-associated incidence density refers to the number of new episodes of infection per 1000 urinary catheter–days. Antimicrobial use during the postoperative period was the secondary outcome measure, summarized by defined daily dose per 100 patient-days [17].

Statistical analysis. The reported incidence of UTI among orthopedic surgery patients is around 10% [18–20]; a target sample size of 310 patients (155 patients each for phases I and II) would be an accurate estimate to ensure with 90% probability the detection of a 30% reduction in the incidence of UTI between phase I and phase II among the intervention group.

Continuous variables were expressed as the mean or median when appropriate. χ^2 Tests or Fisher's exact test were used to compare proportions and rates, and continuous variables were compared using Student's t test or the Mann-Whitney U test when appropriate. Analysis of variance was used to compare demographic data among the 3 phases for orthopedic surgery patients. Data were analyzed using Statview software, version 5.0 (SAS Institute). A P value <.05 was considered to be statistically significant.

RESULTS

Patient Population and Overall Incidence of UTI

A total of 1328 patients were prospectively surveyed: 529 patients before intervention (phase I), 499 patients immediately after intervention (phase II), and 300 patients during the 2-year follow-up (phase III) (figure 1). Patient characteristics at baseline, surgical procedures, anesthetic techniques, and median dose of morphine administered in the postanesthesia care unit were similar during the 3 phases for orthopedic surgery patients (table 1) and during the first 2 phases for abdominal surgery patients (data not shown). After surgery, 1107 (83%) of 1328 patients were transferred to the postanesthesia care unit, 175 (13%) of 1328 returned directly to the surgical ward, and 46 (4%) were admitted to the surgical intensive care unit.

The overall incidence of UTI in the study population was 6.6 episodes per 100 patients in phase I versus 2.6 episodes per 100 patients in phase II (table 2) (relative risk, 0.39; 95% CI, 0.21–0.71). The frequency of UTI increased with the severity of underlying illness (among ASA class 1 patients, 1.4%; among ASA class 2 patients, 3.3%; among ASA class 3 patients, 9.7%; among ASA class 4 patients, 17.4%; $P < .0001$). Infection developed after a median of 6.5 days (range, 2–44 days) of catheterization. Most infections (80.5%) were monomicrobial, with enterobacteriaceae as the predominant pathogens (72% of monomicrobial infections). Pathogen distribution was similar in the 3 study phases; the most common isolates were *Escherichia coli* (52%), other enterobacteriaceae (20%), enterococci (11%), *Pseudomonas aeruginosa* (7%), and *Candida* species (9%).

Intervention Group: Orthopedic Surgery Patients

Impact of intervention. Twenty-nine hospital-acquired UTIs were observed during phase I versus 10 UTIs during phase II ($P = .004$), which represents a 59% decrease in the incidence density of UTI (table 2). The frequency of performance of urine analysis following urinary catheter removal was similar in phases I and II (93 [91%] of 102 patients and 76 [90%] of 84 patients, respectively; $P = .87$).

Adherence with guidelines was 82.2%. Bladder catheterization in the postanesthesia care unit or surgical ward was performed in 11 patients (3.9%) during phase I and in 17 patients (6.6%) during phase II ($P = .17$). A significantly higher proportion of patients had a urinary catheter for ⩽3 days after intervention, and a shorter mean duration of catheterization was also observed (table 3).

The occurrence of infectious complications other than UTI, as well as noninfectious complications, was similar during phases I and II (table 4). Overall recourse to antibiotic therapy after surgery decreased from 17.6 defined daily doses in phase I to 15.6 defined daily doses in phase II ($P < .005$) because of the reduced need for the treatment of UTI (table 4). Three patients died during phase I, and 2 died during phase II ($P = .71$); deaths were unrelated to UTI.

Follow-up at 2 years. Eleven hospital-acquired UTIs were

Table 3. Urinary bladder management in orthopedic surgery patients during the study phases.

Variable	Preintervention (n = 280)	Postintervention (n = 259)	P[a]	2-year follow-up (n = 300)	P[b]
Urinary-bladder management in operating room					
Initial urinary catheterization	88 (31.5)	62 (24.0)	.052	47 (15.7)	.01
Intermittent catheterization	1 (0.4)	1 (0.4)	>.99	0	.46
Previous long-term urinary catheterization	15 (5.4)	17 (6.5)	.55	15 (5.0)	.43
Bladder ultrasound examination in PACU	28 (12.8)	21 (10.4)	.46	4 (1.7)	<.001
Urinary catheterization in PACU[c]	4 (1.4)	8 (3.0)	.19	3 (1.0)	.08
Urinary catheterization in surgical ward[c]	7 (2.5)	9 (3.5)	.5	11 (3.7)	.90
No. of days of urinary catheterization[d] (range)	5.0 (1–29)	3.9 (1–31)	.02	6.4 (1–56)	.05
Duration of urinary catheterization ⩽3 days[d]	50 (51.5)	49 (67.0)	.04	24 (43.0)	.006

NOTE. Data are no. (%) of patients, unless otherwise indicated. PACU, postanesthesia care unit.

[a] Phase I versus phase II.

[b] Phase II versus phase III.

[c] Includes indwelling urinary catheter and intermittent catheterization.

[d] Patients with long-term urinary catheterization were excluded.

observed during phase III, with an incidence of 3.7 episodes per 100 patients; the incidence density of infection remained low: 21.2 episodes per 1000 catheter-days. Urine analysis was performed 53 times following urinary catheter removal (82%, $P = .11$, compared with phase II). Adherence with guidelines was 80.8%. Only 47 of 300 orthopedic procedures (15.7%) were performed after urinary catheter placement in the operating room (table 3). Bladder catheterization in the postanesthesia care unit or surgical ward was performed in 14 patients (4.7%; not significant, compared with phase II).

The occurrence of noninfectious and infectious complications other than UTI is shown in table 4. Despite a higher incidence density of pneumonia, recourse to antibiotic therapy following surgery remained stable, compared with phase II, which is consistent with a reduced need for the treatment of UTI ($P = .002$) (table 4). Two patients died; deaths were unrelated to UTI.

Control Group: Abdominal Surgery Patients

The incidence of UTI was stable during the 2 phases of observation (table 2). The frequency of the performance of urine analysis following urinary catheter removal was similar in phases I and II (101 [89%] of 114 patients vs. 76 [86%] of 88 patients; $P = .63$). In the postanesthesia care unit, bladder ultrasound examination was performed 42 times during phase I and 20 times during phase II ($P = .005$). Bladder ultrasound examination tended to be less frequent in phase II with 3 patients, compared with 10 patients in phase I ($P = .06$). The incidence of urinary catheterization in the surgical ward remained unchanged at 2%. Nine episodes of bloodstream infection were recorded in phase I, and none were recorded in phase II ($P = .008$); 2 episodes were secondary to UTI. The occurrence of other infectious complications was similar during both phases. The overall use of antibiotics was higher in phase I (16.6 defined daily doses vs. 11.9 defined daily doses in phase II; $P < .001$) because of increased recourse for the treatment of bloodstream infection. Three patients died; deaths were unrelated to UTI.

DISCUSSION

The incidence of UTI following orthopedic surgery decreased by two-thirds following the intervention, and its benefit persisted after 2 years. The impact of such a prevention strategy could be very substantial both for patient safety and consumption of health care resources. The 2002 National Hospital Discharge Survey reported estimates of 574,000 total joint arthroplasties performed in nonfederal hospitals each year [21]. Considering a basic incidence of ~10%, >23,000 UTIs could be avoided each year in the United States, which would result in considerable economic cost savings and reduction in antibiotic use.

We focused our intervention on orthopedic surgery patients. Of note, the 10.4% incidence rate observed during the preintervention phase among these patients is within the expected ranges of published prospective studies which report rates of 6%–24% with a mean average of 12% [5, 18, 20]. Besides generating extra hospital costs, these infections are a source of gram-negative secondary bacteremia in 0.5–7.7 of 100 patients [2, 7], with potential harmful damage and additional hospital expenditure [1, 16, 22, 23] and may constitute an important reservoir for the selection and spread of multidrug-resistant organisms [3]. Studies have also suggested severe morbidities associated with UTI [5, 6, 24, 25], in particular, distant joint infections after hip or knee arthroplasty [24, 25].

Exposure to a urinary catheter is the major risk factor for infection [1, 3, 4, 7]. Intraluminal colonization by reflux of organisms from a contaminated drainage bag or by a break in

Table 4. Nosocomial infections other than urinary tract infection, antibiotic consumption, noninfectious complications, and RBC transfusion over the study phases in orthopedic surgery patients.

Variable	Preintervention (n = 280)	Postintervention (n = 259)	P[a]	2-year follow-up (n = 300)	P[b]
Incidence density of nosocomial infections other than urinary tract infection[c]					
Pneumonia	0.44	0.0	.15	1.40	.02
Surgical site infection	1.30	0.27	.17	1.17	.14
Bloodstream infection	0.22	0	.70	0	
Miscellaneous	0.67	1.09	.50	2.11	.25
Antibiotic therapy following surgery, DDD per 100 patient-days					
Antibiotics for urinary tract infection	3.9	2.0	<.001	1.15	.002
Antibiotics for other reasons	14.0	13.6	.52	15.6	.01
No. of patients with noninfectious complications	18	13	.46	24	.14
Reoperation	9	5		6	
Cardiovascular events	1	3		8	
Bed sores	4	3		2	
Miscellaneous	4	2		8	
No. (%) of patients with RBC transfusion	92 (33)	75 (29)	.33	86 (29)	.93

NOTE. DDD, defined daily dose.

[a] Phase I versus phase II.

[b] Phase II versus phase III.

[c] Defined as the no. of episodes per 1000 patient-days.

the closed drainage system is now a rather infrequent event [3, 7, 14, 26]. External colonization by direct inoculation of organisms of the periurethral area at the time of catheter insertion, or later, by ascending in the mucus film between the catheter and the urethra, is the most frequent mechanism of infection [26]. Once organisms gain access to the catheterized urinary tract, the level of bacteriuria usually increases steadily within 24 h–48 h [27]. Rate of acquisition of high-level bacteriuria is ~5% per day [28]. The key control measure for the prevention of infection is limiting catheter use and duration [3, 7, 10]; both use and duration were reduced by our intervention consistent with its impact. Urinary bladder and voiding problems are common after surgical procedures, and their management remains controversial. Standard practice has been to use an indwelling catheter to prevent postoperative retention and bladder distension [18, 29]. Despite reduced recourse to urinary catheterization at time of surgery, no increase in either the postanesthesia care unit or in the surgical ward was observed subsequent to our intervention, suggesting that standard practice could be reviewed to the benefit of patient safety.

Enteric gram-negative organisms and enterococci recovered from the catheterized urinary tract are commonly associated with antimicrobial resistance [1, 3, 4, 7]. An important consequence of our intervention is the decrease of antibiotic prescription, which was clearly associated with a reduced incidence of UTI. Whether the wider application of our strategy would significantly impact on antimicrobial resistance acquisition in hospitals deserves further testing.

Clinical guidelines are one option for improving quality of patient care [1, 30]. It appears important to more-accurately target patients in whom the insertion of a urinary catheter is futile. In this study, several reasons accounted for guideline acceptance. First, the guidelines were developed by a multidisciplinary group of local experts and, although there was no "physician champion" involved [31], the strategy was strongly supported by the physician and nurse leaders in all departments concerned [14, 32–34]. Second, they were tailored to local practice patterns and were based on available scientific evidence [32–35]. Third, they were adapted to each location of patient stay during the perioperative course, assuming the involvement of all health care workers [34]. Importantly, our guidelines were followed in >80% of cases, which compares favorably with quality-improvement reports [34, 35]. Whether the additional use of automatic computer-based protocols could further improve compliance deserves further evaluation [36].

One of the most important results of our intervention is its sustained impact. In particular, the frequency of catheter use decreased in the operating room not only immediately after guideline implementation, but also could be observed 2 years later. Notably, this reduction (53% in 2 years) is paralleled by a 64% decrease in the incidence of UTI and a significant reduction in antimicrobial use. Infection prevention is a critical

component of patient safety [1] and has been recently selected as the first challenge of the World Health Organization World Alliance for Patient Safety [37]. Avoiding or shortening the duration of use of a medical device is among the most powerful strategies for the prevention of infection [1] and is proposed in most guidelines, as well as in "bundle strategies," such as those proposed by the US Institute for Healthcare Improvement [38]. However, availability of guidelines does not ensure their application in everyday practice. Behavioral change remains a formidable challenge [1, 39]. As reported previously and applied in the present study, effective interventions to promote behavioral change must be multifaceted [14, 33–35, 38–42]. Feedback of performance and results was only made available after the intervention but might have been critical to ensure its sustained effect [34, 35, 40].

Our intervention differs in many respects from the approach proposed by the US Institute for Healthcare Improvement "care bundles" [38]. In particular, our study involves a concurrent control group and a 2-year follow-up evaluation that was unobtrusive; performance feedback was not used during the intervention. Furthermore, as proposed and used, guidelines for urinary catheter use are new, are tailored to local practice patterns and the population served, and have not been subject to prior evaluation. Before use in "care bundles" on a larger scale, our results merit further evaluation in other institutions.

This study has some limitations. First, it was performed at a single medical center and deserves further testing in other institutions. Second, although patients were prospectively followed until hospital discharge, long-term postdischarge surveillance was not conducted systematically for all patients; this, however, does not affect the major study outcome. Third, uncontrolled factors, such as variations in physicians' skills or individual commitment to prevention, may have contributed to the decreased infection rates. However, such confounders are unlikely to explain both the overall impact and the long-lasting effect of the intervention. Our study was classified as B1 in the hierarchy of quasi-experimental study designs in the fields of infection control and antimicrobial resistance [11].

UTI is common, economically costly, and morbid. Simple guidelines designed for specific patient groups during the perioperative period can decrease its incidence by >50% and reduce antibiotic use without increasing morbidity. By focusing our strategy on anesthetists, the postanesthesia care unit, and the surgical ward nursing staff, we emphasized their role in preventing postoperative infection. Specific strategies to implement guidelines are necessary to ensure significant changes in practice and improve patient safety.

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